NASA OFFICE OF PUBLIC AFFAIRS
WASHINGTON, D.C.

NASA's 50th Anniversary Lecture Series

"**Inspiring Innovation and Exploration**"

Keynote Speaker:

DR. ERIC SCHMIDT,
Chairman of the Board and CEO of Google

Also Present:

JOANNE MAGUIRE, Executive Vice President,
Lockheed Martin Space Systems
HON. BART GORDON, Chairman,
Committee on Science and Technology,
U.S. House of Representatives
SHANA DALE, Deputy Administrator, NASA

1:20 p.m. through 2:20 p.m., EST
Thursday, January 17, 2008

Newseum
555 Pennsylvania Avenue N.W.
Washington, D.C.

P R O C E E D I N G S

MS. MAGUIRE: Good afternoon, everyone. My name is Joanne Maguire. I am the Executive Vice President of Lockheed Martin Space Systems Company, and I am just very pleased to welcome all of you to this second in a series of distinguished lecture series for NASA's 50th Anniversary.

These lectures are designed to highlight the extraordinary ways in which our nation's space program has brought both tangible and inspirational benefits not just to the American public but to the world at large.

I would like to ask all of you to please join me for a moment in congratulating NASA for nearly 50 years of really truly remarkable achievements.

[Applause.]

MS. MAGUIRE: All of us at Lockheed Martin are proud to have been a strong and trusted partner of NASA since its inception, and this lecture series is the latest manifestation of our half-century relationship.

As NASA's partner on the Orion Crew Exploration

Vehicle, we anticipate our stars will continue to shine together for many decades to come. There is no question that the greatest discoveries are yet to come as NASA and our nation pursue a bold new era of exploration.

Joining us today is Shana Dale, Deputy Administrator for NASA. Shana, we are delighted to be partnered with NASA for this special lecture series and to have partnered with NASA for these many years on our nation's vital space achievements.

Today, our latest achievement is securing the services of Dr. Eric Schmidt, Chairman and CEO of Google, with us today as our distinguished speaker. We are honored to have you with us today as well, Dr. Schmidt, and we look forward to hearing your comments.

To introduce our speaker, it is my great pleasure to have Congressman Bart Gordon, Chairman of the U.S. House Committee on Science and Technology and Dean of the Tennessee Congressional Delegation. Congressman Gordon's commitment to responsible bipartisan efforts to advance science, technology, and education has been really the hallmark of his congressional service. He is highly regarded for his work on issues important to NASA and has

fought for additional funding to ensure that the agency maintains a robust and balanced set of programs in science, aeronautics, and human spaceflight.

Congressman Gordon, please.

[Applause.]

REPRESENTATIVE GORDON: Thank you so much, Ms. Maguire, and more importantly, I want to thank Lockheed and the News Museum for your hospitality here tonight or today.

Oh, there's the Capitol, too. That was good timing. Thank you for that.

And NASA, thank you for putting together this 50th Anniversary Lecture Series. In that regard, it is interesting to note that the House Science and Technology Committee is also celebrating a 50th anniversary this year. Both NASA and our committee are children of Sputnik and the inspiration for so many of the folks that were early involved in the NASA program.

It is my great pleasure to be able to introduce Dr. Eric Schmidt today. I can really think of no one that is more appropriate in speaking to us today about inspiring innovation and exploration as Dr. Schmidt.

I have a long sheet of his resumé, but rather

than take his time, you can all Google him. I am sure he has heard that before.

[Laughter.]

REPRESENTATIVE GORDON: He really is in a rarified air of those CEOs that have been able to take a company and take it from a noun to a verb. My generation, I still say "Can I Xerox this?" or "May I have a Band-Aid or a Kleenex?" So now you have joined that very small realm of verbs or nouns to verbs.

I think also that Google exemplifies the critical importance of innovation and R&D that is necessary if we are going to continue the quality of life that we have in this country.

I was talking to Ms. Maguire. She has a 7-year-old daughter, and I have a 6-year-old daughter. I am very concerned that when you look around the world now, there are almost 7 billion people in the world, half of which make less than $2 a day. If our daughters are going to be able to inherit a nation with a standard of living that is going to be even better than ours, then we have to do it through innovation and research. We have to be making 50 or 100 widgets for every one widget they are

making elsewhere.

I was reading today about cloning. I don't know whether, Dr. Schmidt, we can clone you or not, but we are going to have to have an increase and really an emphasis in this country on research and development, so that our kids won't become the first generation of Americans to inherit a national standard of living less than their parents. It is a real challenge. You are going to be a part of being able to solve that challenge.

I am glad you are here, and I am sure people are glad that I am not going to take any more time from your speech.

I will say that, hopefully, we might get you cloned someday. We can clone animals now, but we can't clone congressmen, and I am in the middle of a vote. I have already missed the first two. So please accept my apologies. I look forward to hearing your remarks that I am sure going to be re-telecast later.

Thank you all.

[Applause.]

DR. SCHMIDT: Well, thank you very much, Congressman, in your busy schedule to come. This is a

congressman who has led a lot of the most important fights for NASA, for science, and for space exploration. His service is phenomenal.

I want to congratulate NASA for its 50th-year anniversary. NASA has been a part of all of our lives for so much of the fantasy and the excitement of being an American and being a citizen of our great country.

I want to talk today about architectures and how systems will work over the next 50 years. I want to think that architecture, as how we go about science and exploration and technology, will be different. It will have to think about it in a different way. I think that the Internet will show a new approach for us, how we can actually build these systems.

Those of you in the audience are people who actually are in charge of how this system will evolve over the next 50 years. Now is the time to think about how to design it, so that we have a tremendous next 50 years.

The next set of missions that the President and others have articulated, Mars and so forth and so on, will span many generations, just as the Internet has, and I want to take you through some of my observations on that.

I also want to take a minute and congratulate the Newseum. Shelby and the team here are in the process of getting organized, launching this formally later this spring. This is a phenomenal accomplishment by all of the people involved with this, and it is a strong testament to America, to the principles that the country has been founded, and all of the things that we care about, and I am very, very proud to have been invited to actually participate in this, what I think is one of the first major public events here.

So let's talk a little bit about NASA, and what I am going to do is have Robin get started. We are going to do a few demos here to give you a sense of what is possible now with some of the things that NASA has been doing. As a pilot, I am actually very grateful for everything that NASA has done, and I think one of the things that people always forget is how much impact NASA has had on things other than space, visual fly-by wire systems, wind shear and icing, a perfect and good opportunity today to take advantage of these new systems built by NASA, jet engine combustors, engine nozzle chevrons, all of these interesting parts of the technology, that you all simply as consumers don't even

notice it.

When I think about NASA and I think about Google, I think of both as being in the business of making things that were amazing commonplace. If you look at the history of aviation, which I know something about, people were terrified with this sort of weather before NASA came along. It was actually a serious life-threatening problem, and now we can deal with it. That is an amazing achievement. It happens every day, and it is going to continue, given the leadership of NASA and the mission of NASA and the things that NASA is trying to do.

When I think about Google, we try to do the same thing. We try to do things that are amazing. Things which were amazingly impossible 10 years ago are now routine. I was trying to think of "aha" moments. I thought what is the most interesting query that I can give, and I thought, "How long will I live?" It seems like the most important question you could ask Google, and since we use Google for everything, I asked Google, and the answer is -- there is an age calculator. I typed in all the parameters, and it came up 67. Bad answer.

[Laughter.]

DR. SCHMIDT: Bad answer, bad answer, rejected answer.

So I reprogrammed the age calculator a little bit, and I came up to 86. A much better answer. I stopped. I moved to other searches. That is an "aha" moment. I know how long I am going to live, and the answer is it is 84, not 67, because Google told me.

Now, Robin, let's start. This is the crookedest street in the world in San Francisco, and you are looking at it with a product called Google Street View. We started off with a view of the Earth, as you saw as we zoomed down, and you will notice you see the folks and the cars. You have street signs and so forth. Is that Alcatraz in the distance there? Maybe you could sort of go. I'm not sure. It's a tourist destination now. Don't worry.

And here we are, and here you are, and you are just on Google wandering around. What is interesting about this is look at the human scale of this experience, this exploration. It seems kind of routine. Right? This is, by the way, phenomenal technology to do this, but before we get too ahead of it, let's keep going.

When we go to the same thing in Google Earth, the

first thing is called "Street View." In Google Earth, we can see everything there is around. The first image that you saw was the same street in Google Earth, and now we are visiting, it looks like, Washington, D.C., and of course, here is the Capitol which is right sort of next door. We can wander around and so forth.

Now, the pictures here include these 3D models of all the buildings, and the shapes that you are seeing and the contours were, in fact, calculated in 11 days in missions in the Shuttle in 2000 for completely unrelated reasons. They decided to do a topography of the Earth, and they happened to, by virtue of their public mission, make it available to everyone. So we just sort of took it and use it. Now when you use Google Earth, you are really following the data that the Shuttle mission calculated.

When you think about Washington, there is a lot of discussions, for example, it turns out that there is a lot of debate about global warming, and this is 5 meters, 15 feet. So the good news is the Capitol is going to be preserved.

[Laughter.]

DR. SCHMIDT: I'm a little worried about the

Smithsonian, and I want you all to look at the NASA Headquarters. It is a little bit of a problem. I think it has an underground parking garage. You're in big trouble.

Not to make a point about global warming or any of those things or sea level change, but there is an article yesterday that says that there is a possibility of this scenario occurring by the year 2100.

Now, why is it important we show this to you now? Because this is an example of the kind of visualization that you can do by taking this platform that represents Google Earth and then showing what could happen. Obviously, we don't want that to happen.

What is interesting about all of this, let's take a look. This is another example of NASA. I think this was Langley that gave us some climate models, and the climate models happen to show the path of Katrina. So we have now overlaid the images that we got from you all essentially, and you can see, as you see the cloud moving, it has information about velocity and position and so forth and so on.

These models were used real time in order to understand what was going on, and of course, you could see

the velocity and that kind of thing. Many, many, many more people participated in understanding the phenomena and obviously also the aftermath. We won't show you now, but there is a large amount of imagery that was done to help rescue missions and so forth, again, overlaid on top of this work, again, in conjunction with NASA.

Let's move to our next one. When I think about the Earth, I also like to think about what are the things that I would like to do, and I have always wanted to climb Mount Everest. Now, if you are looking at me, this is clearly not going to happen.

So what we decided to do, I was just sitting in my office one day and I thought let me just climb Mount Everest on Google Earth.

[Laughter.]

DR. SCHMIDT: So here we are, and we sort of wander up. You can see the South Col and so forth and so on, and this is the vision, and I have achieved my objective.

Well, have I? Yeah. Actually, I have. I have a sense of it. I have a sense of what it is like to be at the highest peak of Earth. Again, I can participate in

this new and interesting way, and by the way, it is really cold.

[Laughter.]

DR. SCHMIDT: When I think about what else I could do, I was talking about aviation, we have a person who is a blogger who covers Google Earth who decided to build a model, a flight simulator. He took a publicly available Swiss fighter pilot video of a Swiss Air Force pilot wandering around the Alps. On one side, you see the actual film, and on the other side, you see the re-creation in Google Earth.

Again, this is available to all of us through the work that NASA and others have done to make it possible to see topography and pictures. This information is satellite and aviation data, and of course, it comes with a great sound track and so forth and so on. Again, someone else, just like me flying up Mount Everest, this is perhaps a person who is unlikely to be flying his own F-18 in the middle of the Swiss Alps. We can really re-create this, and it is just a phenomenal experience.

We have many, many technologies coming that are like this over the next little while. In fact, here is a

picture of the fake pilot. There is a picture of the real pilot. So this author even inserted a picture of himself in it.

Let's move to our next one. When I think about this whole phenomena, how we use information, I then think about scale. I was trying to think about what is the best example that I can use about scale, and I was trying to think about, well, there is the moon sort of nearby. So what we have done now is we have simply taken imagery of the Moon. Thank you, NASA. It is, by the way, Moon.Google.com, in case you want to go visit the Moon, if you are currently planning on a Moon mission anytime soon.

Here we are. Let's go visit where Neil Armstrong went, and you will see that we can, in fact, get to the point where you can see a picture of his footprints.

Now, the kind of stuff that I am talking about we did under a Space Act Agreement with NASA, and we are showing not just NASA planetary content, as we have discussed, but also we are working on disaster response. Here is a picture of Neil Armstrong's footprints. Again, these pictures are given to us by NASA and others. This mechanism is generically available on all of Google Earth,

so, again, showing off what we can do.

Let's keep going. If you are on the Moon, perhaps what you are really interested in is space. So let's go to a particular interesting star field. This star field looks like a normal star field. It was actually done in the Deep Space Initiative with the Hubble, and this is a picture. To give you an example, the width of that picture is somewhere around 10-to-the-25 centimeters, which is a number that is -- here is an analogy for you. The interaction between carbon atoms is maybe 1 over 10 to the minus 12th in terms of the way they interact, and 10 to the 12th is on the order of 100,000 years. So what you are seeing is you are seeing something that has the scale or width of something you have never seen before. There is nothing in the world of this scale. This is the deepest image. It is also the oldest image we have in history because it was done approximately 13 billion years ago, roughly 10 percent of what we believe the life of the universe is.

It was not done with one picture, by the way. The Hubble went around and took picture after picture after picture because there was so little light. Pretty neat.

Okay? So you say normal picture. Let's see where that picture is in context, so you get a sense of how far it really is.

Oh, it looks like a pretty normal star field, and by the way, there are billions and billions of stars and galaxies even in this field. As we move out, we begin to see that perhaps this is a tiny, tiny, little piece of a tiny, tiny, little constellation that doesn't even show up on our constellation map. As we go deeper and deeper and deeper in both time and in history, some of our constellations begin to show up, and now we begin to see what is familiar to us.

There is no tool and there is no feature I know of on Earth that can show you a resolution that goes from 1 to 10 to the 25th in that amount of time. That is what NASA can do. That is what information technology can do, and that is, frankly, why we all work at Google.

Let's thank Robin for the demo.

[Applause.]

DR. SCHMIDT: So, if you think about it, what you really do is you set up audacious goals, and you make this all happen, but you cannot possibly anticipate the

challenges that you have to surmount.

It is clear that the assumptions will change, and you cannot predict the innovations that engineers will make. The Internet architecture was invented in 1973. The World Wide Web was invented in 1991, 1992. The protocols that we deal with every day now that are so commonplace were not even thought about until 20 years after the original design. That is a remarkable achievement of technology in computer science.

There is no way to understand how people will take advantage of this technical innovation. A man in Italy used Google Earth to discover the remains and antiques of an ancient Roman villa literally in his back yard. Archeologists in France used Google Earth to discover 100 candidate sites for ancient Celtic settlements. In search for the various meteor craters, the impact craters, they are using the satellite imagery from NASA and the other work in order to actually do real science on how the Earth was formed and shaped. We didn't anticipate all of this. We just put the data out there, and people did it.

It is also clear to me that the people who start

the mission are not the ones who are going to complete it. An interesting fact that I made in researching this is that the average age in the front room of Apollo 11 was about 32. The average age at Google is about 31. The memory of the IBM 360s -- I used as a young programmer, an IBM 360/91, which will both date me and also give you a lot of sense of sympathy for me, 2.5 megabits in core memory, real cores. The memory of the iPod that our average employee carries now is 80 gigabytes, which is 256,000 times 2.5 megabits. So the rate of change here has been so phenomenal. It is of the scale that I just showed you in that star field.

So the Internet is fastest growing communications medium in history. Again, it is so fitting that we are here at this wonderful museum. More than 1.3 billion Internet users worldwide, on the order of a couple hundred million new users every year, 8 hours of video uploaded to YouTube every day -- actually every minute, and there's 70 million blogs that exist and 120,000 created every day. That is a lot of blogs and a lot of writers, not so many readers I suspect.

[Laughter.]

DR. SCHMIDT: This democratization of information, which is fundamental to what is occurring here, has a lot of implications for both NASA and for Google and for the world here in Washington. Since anyone can create, edit, publish, and share information, it is a new jump ball. It is a new scenario. Normally, what happens is that the rate of progress in fields occurs at a relatively predictable rate. Examples would be that in scientific research, the number of papers doubles every 15 years, so a sort of predictable rate. In astronomy, since we are sort of talking about astronomy right now, the distance of the farthest galaxy we can see has doubled roughly every 10 years, so, again, reasonable rates. The world that I live in, doubling times are much, much shorter.

Moore's Law, of course, everybody knows about this. Processing power doubles every 18 months. That means, by the way, 10 times every 5 years, 100 times in 10. There is a law called Kryder's Law which is that memory, disk memory in particular, doubles every 12 months. So there are immense, immense amounts about data stores being created over and over again.

An obvious example is that in 2019, an iPod-type device would be able to contain 85 years of video. In other words, you could never watch it. You would be dead. You are going to be carrying it, and you would say, "Well, I couldn't watch it. I'm sorry. I died." I mean, that's a serious problem, like it is going to cause a lot of stress. You know, if I had only lived another year longer, I could have watched another episode.

The other interesting thing about this inspersion of information is that there is a lot of new voices and new ideas. With all that content out there and the search is obviously what Google does, it becomes more important than ever. Over 20 percent of the searches that we do every day are for items we haven't seen in at least the last 90 days. So people are naturally curious, and I want us to take advantage of that curiosity.

To hear some ideas for success as we think about this, the buzz words that we use in computer science are "open, scalable, and flexible architectures." A lot of the NASA work was done before that became the -- that is the most politically correct way I can say this -- before those became the principles of design. These hardware designs

that are not extensible ultimately do not serve the mission very well.

In my case, to show you how foolish I was -- and I was a graduate student at Berkeley -- I build a network, one of the first networks built of its type, for my master's thesis, and by the way, I got my master's thesis, and I designed a protocol. There were only four at the time, and I couldn't imagine that the university would ever have more than 26. So the machines were called A, B, C, D, et cetera. They still gave me my degree, and then shortly later, they tore out my network and put in a proper network. So everybody can make this mistake.

The Internet started off with four nodes. It now has somewhere between 250,000 and a million broad networks, by any definition. It is just phenomenal.

The number of servers, there were roughly -- January 1983, we have an accurate number because of DARPA -- 400 servers. In July 2007, our best estimate is 489 million servers, and this is growing and continuing to grow. It is growing faster than you think. It is growing all the time.

So, when you build an innovation model, you want

to build it in a way that is collaborative, and this is often at odds with how people think about government programs, procurements, the traditional structures of business and private groups and so forth and so on. You want to figure out a way to do it in a much more open way, and everybody loves what NASA is doing. It should be possible to pull this off big time.

The Web, for example, today is built out of products known a Linux, Apache, MySQL. These are open software technologies. The creators of MySQL, by the way, just in case there is any concern that these might be hobby businesses, they were just purchased for about a billion dollars by Sun Microsystems. These are real businesses with different characteristics, but it shows you that you can really deliver tremendous value.

So, if you solve the problem, solve it by opening it up to the public. Assume that you don't have all the answers because I can assure you that we don't, and I suspect nobody does. Everything is too connected. You are not getting the benefit of every one of us. You figure out a way to do it an open way.

There's a couple of really good ones. NASA did

something called the Centennial Challenge Program, and I think one of the people here was one of the authors of this program. So thank you for that. A particular engineer from Maine won $200,000 in May 2007 for designing a new astronaut glove. The inner bladder of the glove used one of his kitchen cleaning gloves because it was the right solution. It just worked. There is example after example of that when you bring in creativity of people. Maybe he didn't have a lot else going on in his life. Maybe he needed something to work on. You just made his day, and you just saved yourself a million dollars, but more importantly, you serve the mission really, really well.

The Lunar X PRIZE that Google has announced, we announced a few months ago, a prize which is graduated, but think of it as between 20- and $30 million. Basically, get something launched, get it to the Moon. Make sure when it lands, it can still drive around. Very straightforward. That is the nontechnical explanation. Look at our website. You can see all the details if you want to bid.

Why would we do this? Because it is fun. It is just so much fun. Now, the people who are going to attempt the Lunar X PRIZE -- and there's a whole bunch of folks --

are probably going to spend more than the value of the prize, but what is nice about the prize is it brings everybody together. It gets everybody's competitive juices, and you get the multiplicative effect not just of the money that we are putting in, the money that NASA is putting in, but the money that all the other people are putting in, which is science in a good way.

Another aspect of the problem that I think we all face has to do with this notion of how do you learn, and in this interconnected world, you have to learn more quickly. Part of the success of the Internet -- and it is true of all of the companies, and Google is simply one of the examples -- is that we are built on a "shift and iterate" philosophy.

What happens is, basically, we try something, we try something, we try something, and we are proud of this, by the way. We celebrate the fact that we tried this, we canceled this, this didn't work, we shifted and so forth. They wiggle in an interesting way, and not only does the technology allow that, but it is part of our culture. We have programs where we encourage our engineers to spend 20 percent of their time on things of their own interest, not

what their manager is telling them that they have to do, again, unheard of in traditional engineering, but it drives much of the creative process inside our company. There are many, many such examples.

Who here was a big Apple Lisa user? It was the predecessor to the Mac. They learned a lot from the Apple Lisa that made the Mac a great success way back when.

It happens in telecommunications. The AT&T long distance network crashed for 9 hours due to a bug consisting of a single line of C code in 1990. We have all forgotten that, but the fact of the matter is they do it, too.

So the obvious message for me is to say, "Well, NASA, you should just shift and iterate this minor problem," that you can't apply exactly the same approach we do because Mars and the Earth are only this close on this day or Saturn is only in this position in this particular place or you have a particular launch window due to orbital mechanics, that you really do have to launch within this window. There are some humorous now but embarrassing at the time examples. Gemini 5 splashed off course 100 miles because of a programming error involving the way they did

the calculation with a decimal point. An even more famous example and unfortunately a negative one in 1962, Mariner 1 went off course, and NASA at the time had to blow it up because of an error in the program, and a hyphen had been dropped from the guidance program loaded aboard the computer. We quote it as the single "most expensive hyphen in history."

So I don't think it is fair for me to say, well, hey, you guys should just adopt this "shift and iterate" phenomenon. I think what you have to do is you have to recognize that the "shift and iterate" model is the best model for learning and then adapt it to the constraints that are very much in your present.

One way to think about it -- and as a manager, I talk to people a lot about this -- is that one of the best ways to be lucky is to create more luck, and the way you create more luck is you have more at bats. You get more shots, more launches, more learning, so forth and so on. So the more you put everything around one single event, the less likely it is going to be a perfect success, the more you figure out a way to iterate, and there are many, many ways in which you can iterate. You can iterate with

openness. You can iterate with extensibility.

Remember the story that I used about the Internet, that the underlying protocols were designed around a simple model of end-to-end connectivity. No one anticipated that all of the stuff that we did built on top of it.

So, given that you have these real constraints about launches and windows and so forth, make the platform such that the simplest possible platform that people can then build on top of. Build open systems, not closed systems. Don't try to solve the whole problem right now. The problem, as correctly defined, in my view, is to build the platform, the thing that is extensible to the next example.

Another example as we are looking at this, most spacecraft can't talk to each other in any significant way. Now, you say, "Well, I'm not sure I want spacecraft talking to each other." Well, actually, it is kind of useful for spacecraft to talk to each other, especially when they can relay information and telemetry and other information, and furthermore, we as a country can use that for many, many different reasons. Well, isn't it obvious

that the spacecraft should have an Internet on them, too? It doesn't have to be an open Internet. You could have your own private copy with a gateway, so people aren't randomly steering the spacecraft wherever they want to go, but the fact of the matter is it does make sense.

In fact, there are people now working. This is a great story. People are working to build an interplanetary Internet, that all the same principles that I am talking about apply not just on Earth -- obviously, we are busy launching, and by the way, not just the U.S., but everybody -- but also the Moon and Mars and so forth and so on, and this Internet is interesting because there is this minor problem that as you spin, you lose connectivity, and you have to wait for the packet. So the whole notion of latency is very different, like a long time before that packet shows up, but then it comes very quickly, and then there is a long time again. We haven't quite figured out a way to solve planetary rotation yet.

So the fact of the matter is you have to design these protocols with a small number of modifications, that it is possible for NASA and the world to have not just an Internet that is part of the Earth, but also an Internet

that goes all the way out there. I don't know if it will get all the way out to the deep space field because it will take 13 billion years to get there, but it will get pretty far.

So, by standardizing the protocols, by standardizing the ways in which things talk to each other, by making sure that when you have multiple vendors, multiple contractors, that they are using a common substrate of communication and extensibility, you have a much, much greater chance of creating an opportunity like the ones I am describing on the Internet, where this platform, this very interesting thing that was designed for one thing, is, in fact, now even more valuable, even more powerful, rather than mission-limited in one way or the other. So the technology base case continues, and I think it is pretty interesting.

What does it look like in 10 years? Processors and phones and computers are 100 times more powerful, storage a thousand times cheaper, a ubiquitous wireless broadband, a cell phone for everyone who wants them in the world. This will occur in our lifetimes, especially since I am living, remember, to 84.

How can NASA take advantage of this? I will give you another example, something fun. NORAD has a program where they know where Santa lives, and they track Santa as he goes around the world. These guys are pretty clever. So they shot videos of Santa visiting various cities and towns around the world, and they had a route, GPS, and you could track it. I thought, "Wow, pretty interesting." How many people look at this? 10 million people had nothing else to do but to follow Santa as he wandered the world visiting and spreading joy around the world. It had a big impact on families and kids. How can we, how can NASA take advantage of that? To me, that is the interesting question.

There is a story about Alan Bean, one of the most famous astronauts, that there is a benefit to being an astronaut. Obviously, to get launched in space? No. The benefit is that you can get the attention of any kid for 5 minutes in wrapped attention. If we can't use that observation to further the mission of NASA and the things that we care about, we are not doing our jobs right.

In many ways, Google and NASA are similar in that they are based on optimism. Pete Worden, who is my good

friend, one of the directors at NASA, says, "Remember that space is hard. It is really hard. It is hard science. It takes an optimist to want to pull all this off," and I like that a lot. You have to be optimistic to want to send a man to the Moon, to Mars, to explore every planet, to build a Space Station. You also have to be optimistic to believe that you can cover all the world's information, starting with borrowed servers in your Stanford dorm room, the same principle, and indeed, we are busy doing as best we can.

Ed Lu, who is a Google employee and I think the U.S. astronaut who has been in space the longest, I asked him sort of what is it like, what did you do all day. He said, "I looked at the Earth. I literally just loved to look at the Earth as it was underneath me."

So what I was thinking about was how can we get that, how can we get that feeling, because if you think about it, every person that I know of basically looks at the world on their cell phone now. How can we get that same passion that Ed had, that same feeling about the world, the world around them, the sense of wonderment?

Today, people spend literally so much time looking at this screen or the other choices as well. How

can we get that information? I think that is our joint mission. How do we get this amazing amount of information that is being generated about the world and science? How can we get that so that it is at the same level of wrapped attention as Ed had sitting, spinning around, looking at the wonderment that is the world around us?

That is why I am such a strong supporter of NASA. That is why Google is such a strong partner for NASA, and that is why we are so very, very happy to wish NASA a great 50th anniversary.

So thank you very much, and I am interested in your questions and comments.

[Applause.]

DR. SCHMIDT: I think that lady has a mic for you. That way, they can hear you on the videotape.

ATTENDEE: David Logsdon, U.S. Chamber of Commerce, Space Enterprise Council.

A few years ago, the futurist Alvin Toffler was at a conference, a space-related conference, where he mentioned that the information age was the third wave, that space was the fourth wave.

In your mind, what do you consider the fifth

wave? Is it a combination of space-related activities and applications? What is your vision for the fifth wave, and with that vision, how can that be a stimulus for the economy?

DR. SCHMIDT: Most people that I talk to in this area actually believe that the next huge phenomena that is going to hit us will be in biology, in biotechnology, the issues and opportunities that the genome, recombinant DNA, and those sorts of things do.

I think all of us are, to some degree, enablers of that next wave, and the argument is pretty simple. In order to do the kinds of things that we want to be able to do for health, society as a whole, improving a lot of the world, we are going to need the kind of information and computing power and networks and learning that is going on today in the other wave that you described.

It is probable that the combination of the creation of this enormous information network that I talked about earlier, the commercialization of space, which NASA and the NASA leadership has done a tremendous job moving it forward if we think about 10 years ago versus now -- again, this also creates a large number of jobs, a large number of

opportunities -- and its openness, making it possible for people to enter the system with the appropriate things, both of those create very large numbers of jobs and probably a significant wealth opportunity for investors. A lot of people believe that as more and more of this stuff has been in the private sector, people will figure out a way to make money because there is economic value.

In Google's case, for example, these satellite images that we showed you, we buy them from commercial satellite providers. They are making money and doing a great job for us, by the way. There are many, many new things of that type that can be done.

One of the reasons that I am here is to say to you all that there are tremendous private opportunities for investment in space technology, high technology, and information technology. Google is an example of it. There will be many others.

Eventually, I think all of us will be subsumed to some degree under this biology and biotech because the promise is so strong. We are not quite there yet because the computers aren't quite fast enough. We don't really quite understand the networks quite well, but everybody is

working on it.

Yes, sir. Let's see if we can get a microphone.

ATTENDEE: Matt O'Connell, GeoEye, one of those commercial satellite operators.

DR. SCHMIDT: And a partner, thank you.

ATTENDEE: Right.

DR. SCHMIDT: Thank you for all those nice pictures.

ATTENDEE: Thank you.

We get criticized for taking pictures of areas that some people think are sensitive, and I know at Google, there has been a debate about whether or not you should show those pictures.

I think the arguments in favor of openness are winning, but I would love to hear your comments because I get it all around the world.

DR. SCHMIDT: From a Google perspective, this question about public information, what is public, what is private, is turning into being one of the sort of central questions for the Internet.

You all should know that there is a law that restricts -- you certainly know this -- commercial

satellite imagery. There is a certain level of resolution which we are governed by, and we need that, obviously. So there, in fact, is some legislation and some regulation in this area.

We have taken a position that subject to meeting the law -- and there are certain countries that have special terms which are even more restrictive with respect to commercial imagery -- we want to get as close to that as we can because we think that society benefits from such pictures. The fact of the matter is that I think we are in a transition period where people are learning that the things they thought were not generally known are becoming more generally known.

My favorite examples are these situations where something from space, people assume that you would never see it from space, but in fact, it is embarrassing or the wrong thing and so forth, and people are making appropriate changes. So I think this is a transitional period.

The benefits of being able to see that third dimension, what pilots see when they fly, turns out to be phenomenal. I talked to Queen Noor about her husband who died, who was a pilot, and she told me the reason he was a

pilot was that when he flew around the Middle East, he never saw any boundaries. He never saw the little lines that we see on the map, which we assume those lines are like etched in the desert. We all know where they are. It is right there on the map, but it really isn't.

I went to a photography show from one of the astronauts who was particularly good at mid format camera photography, showing what the Earth really looked like, and I think that it is both a message of peace, but also a message of the importance of the Earth that I think we want to get out.

There are some things that we do to be responsive to this. We are very, very careful not to show real time because we think real time could be misused, and you can imagine 20 ways in which real-time images could be used. We also have various mechanisms for things which are sensitive or inappropriate to try to consider whether we should remove those as well. So we want to be sensitive to that, but the overwhelming conclusion is that society benefits from more of that kind of imagery being available, and thank you for helping make that happen.

More questions? Way in the back.

ATTENDEE: Chris Kemp out at Ames Research Center.

Increasingly, collaborative technologies are free, and systems are increasingly being developed in open source, and it is hard to procure what is free. What advice do you have for Federal agencies that are trying to use tools which are free?

DR. SCHMIDT: Again, the government, which has like a trillion-dollar deficit, can't buy something which is free. It has to buy something which costs money. Does that -- everyone says yes. Okay.

[Laughter.]

DR. SCHMIDT: Welcome to Washington, I guess.

Even the technologies that I was describing that are free typically come with a support burden. So what companies do when they work with the companies that I mentioned is they actually do a procurement in the Washington sense or in the government sense, but they do it for a service. The software itself is free, but the support, its integration, and so forth, that works pretty well. We use the term "free," but we all understand that people are paying for this. They are paying for

engineering, they are paying for support and so forth and so on, and that is where the rub is being created.

Put another way, sometimes you pay for the software. Sometimes you pay for the service. At the end of the day, you are going to pay for something. So it has to do with what you are procuring.

There is no question that the generation of computer people that I work with now are all building on top of this Linux platform which is open source, but they are building tremendous companies. Google, of course, is largely Linux-based, to give you an example, and obviously very successful.

More questions?

[No response.]

DR. SCHMIDT: Well, thank you for inviting me. Thank you all for a wonderful afternoon, and I hope you all get home in the middle of the storm. So thank you very much.

[Applause.]

MODERATOR: That concludes our program. I would like to thank Dr. Schmidt for joining us today. Thank you very much, Dr. Schmidt.

I would like to thank Google as well.

I would also like to thank Lockheed Martin for their tremendous support in bringing this event together.

Finally, I would like to thank the Newseum for a wonderful facility.

Thank you to all of you. Have a wonderful day, and again, safe travels.

[Applause.]

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